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(54) A Building, and Method of Heating a Building

(57) A heat pump (46) is used for heating a building. Heat is extracted at the primary end from an outer wall (20) of the building, which is in contact with the ambient, by means of a heat exchanger embedded in the wall and associated with the heat pump evaporator (56). An inner wall is thermally insulated (24) from the outer wall (20) and is used as a secondary accumulator, heat being transmitted to the interior from the inner face of the inner wall. The inner wall is provided with a heat exchanger associated with the heat pump condenser (60).

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

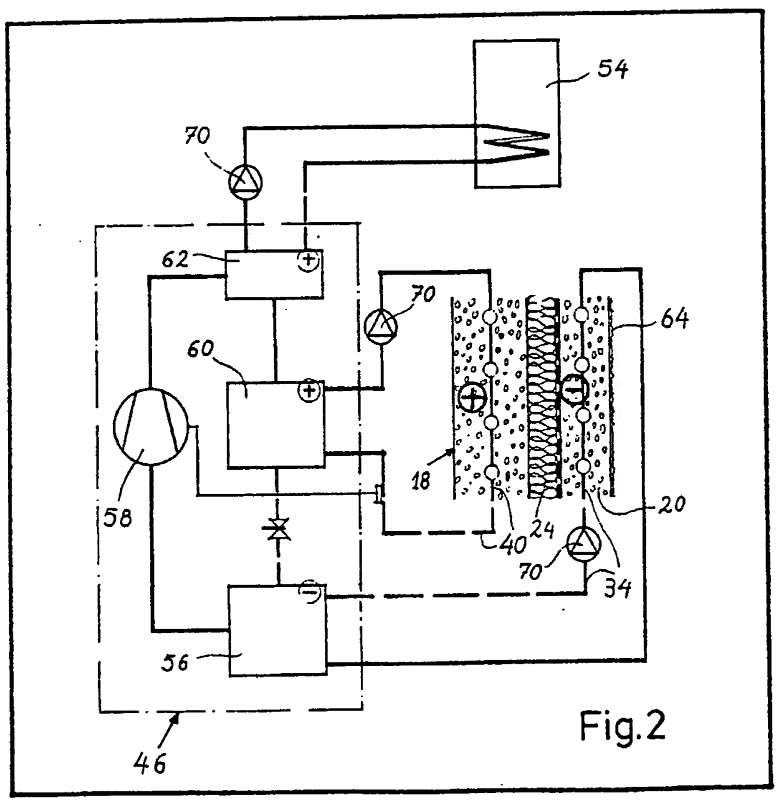

Fig.2

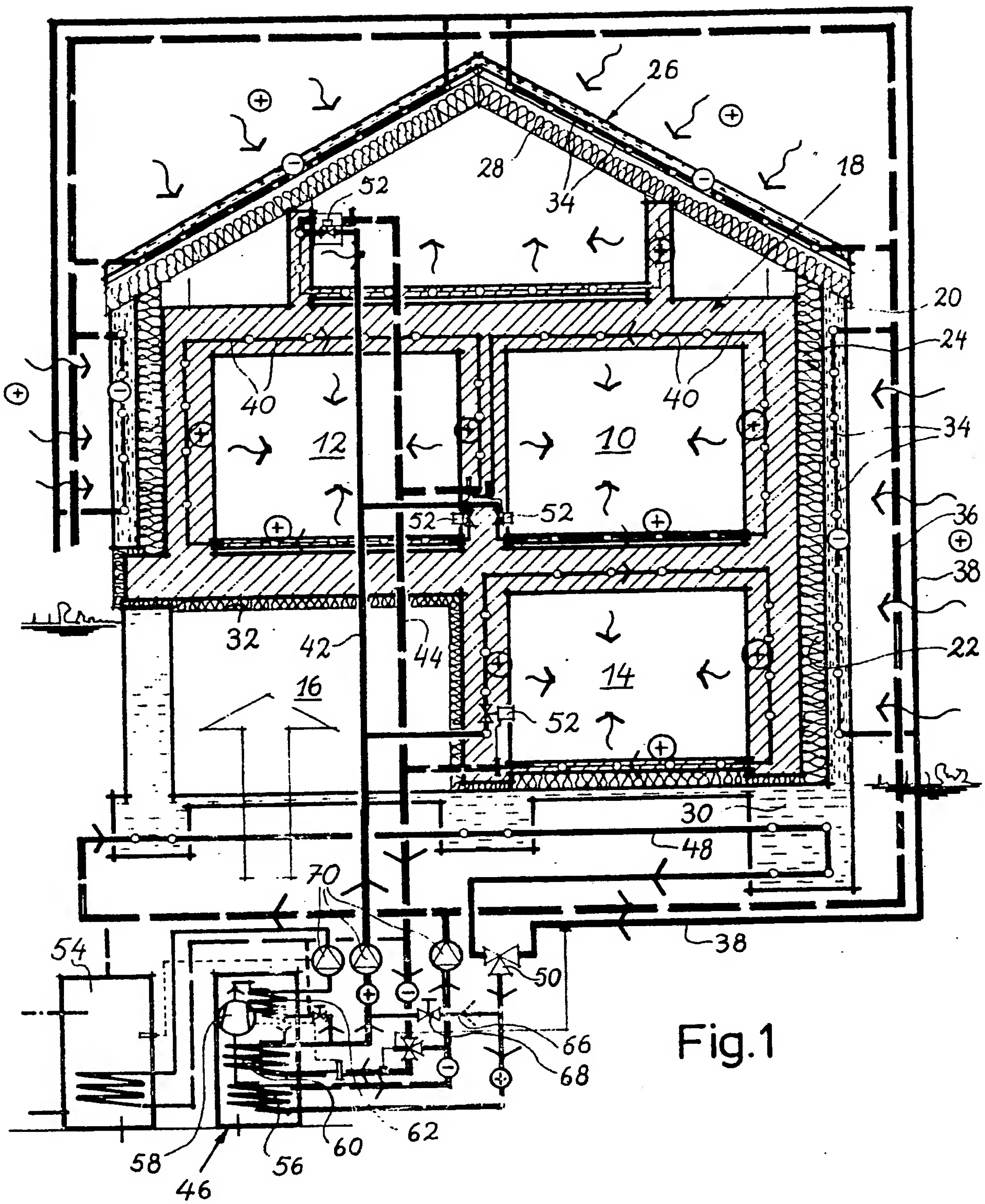
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Fig.1

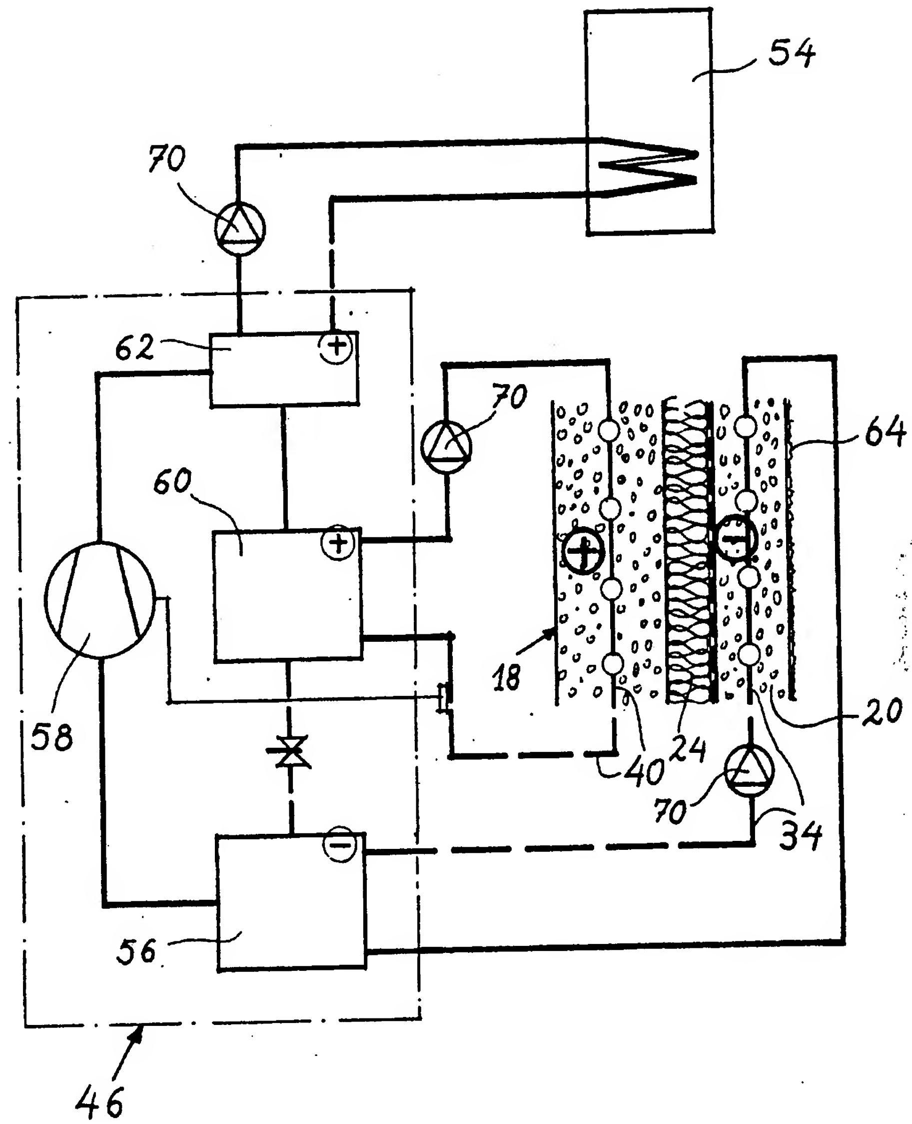

Fig.2

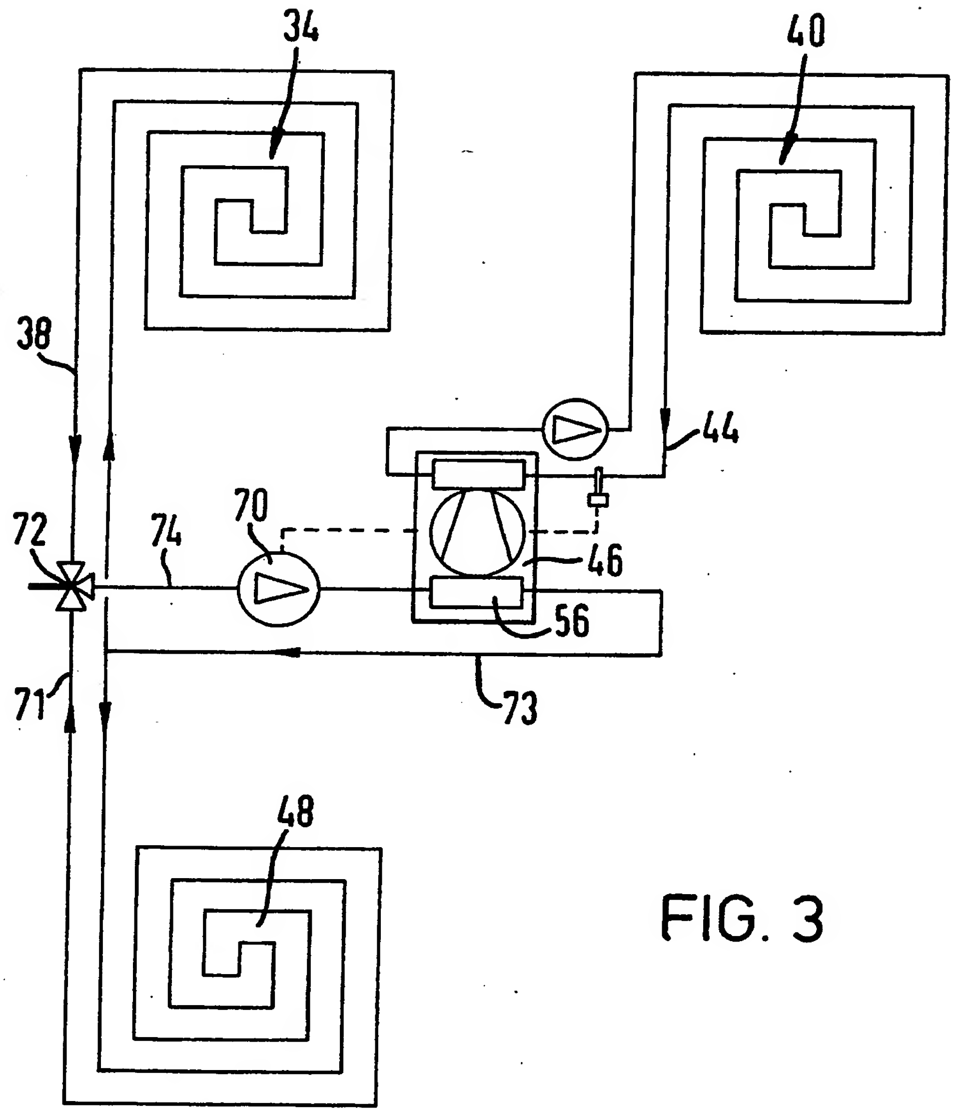

FIG. 3

SPECIFICATION

A Building, and Method of Heating a Building

The invention relates to a method for heating the rooms of a building, using at least one heat pump by which the thermal energy extracted from a body by means of a liquid agent is supplied, after having first been upgraded or downgraded, to at least one reservoir from where it is extracted for heating up the rooms of a building.

It has been generally known in the art to employ heat pumps for heating up rooms.

However, a disadvantage of this known heating method must be seen in the fact that heat pumps are frequently unable to master the necessary high temperature difference. For this reason, such heating systems are generally supplemented by a conventional heating system so that the required energy is generated by a double heating system (two-condition system) in which the conventional heating system covers the peak consumption of thermal energy.

Another disadvantage resides in the fact that when one of the energy sources breaks down a two-condition systems of this type will no longer be fully operative, and when for instance the supply of electric current is interrupted, the heat pump will become inoperative, too.

Moreover, heating systems of this type need radiators and a heat accumulator as buffer reservoir. But if a comfortable room temperature is to be achieved with this system, the heating water temperatures must be very high which means that the heat pump can be used economically only down to a temperature of approx. +5°C.

Furthermore, the use of heating pumps proves uneconomical during the colder periods of the year because heat pumps extracting the heat from the air must be continuously defrosted. Finally, the heat accumulator requires much space, quite apart from the fact that the operation of the conventional heating results in environmental pollution.

Now, it is the object of the present invention to provide a method of the type described above which eliminates the before-mentioned disadvantages of the known heating systems using heat pumps.

According to the invention, this problem is solved by a method in which the building masses surrounding the rooms to be heated are used as accumulator.

This solution offers the following advantages:

By using the building masses as radiator and/or energy accumulator, a comfortable room temperature can be achieved without the need to raise the temperature of the heating agent to the high levels heretofore necessary, because now only a very low temperature difference is required between the heat source and the heat-radiating means (building mass).

Accordingly, the method of the invention renders it possible to keep the average heating-water temperature at a level of only 24° to 28°C. This advantageous effect is achieved last not least by the considerably increased radiating surface obtained by the use of the building masses.

Another essential advantage of the invention resides in the fact that no radiators are necessary for heating the rooms. Likewise, it eliminates the need for a heat accumulator for the heating water.

Accordingly, the method of the invention does away with the need for the conventional two-condition heating system for heating the rooms of a building and, accordingly, with the environmental pollution resulting from the latter.

As a result, the usually quite extensive automatic regulating means are no longer needed, either.

Because of the low consumption of electric current by the heat pump to be used in the method of the invention, the latter may even be operated in cases of emergency by a conventional emergency power unit so that the uninterrupted supply of energy is warranted at any time.

Due to the fact that the building masses are used as heat accumulator, the heat accumulation capacity of the heating method is so high that comparing equal periods of time, the temperature drop per time unit occurring in the method of the invention reaches only a fraction of that of conventional heating systems.

The body to be employed as source of the thermal energy may be of the most different kinds. For instance, the thermal energy may be derived from the earth or the ground water, or else from a river, provided the nature and configuration of the surroundings offer such possibilities for extracting thermal energy.

A particularly advantageous feature of the invention is seen in the fact that the body from which the thermal energy is extracted, is integrated into the building mass. This offers the advantage that no special area is needed.

The use of the building mass makes it possible for its surface to absorb and incorpate into the energy gen ration, the sum of diffuse, direct and atmospherical radiation encountered in the surroundings of the building mass, so that practically an unexhaustible energy source is available. When the energy consumption exceeds the energy gain from this radiation, the system will draw upon th thermal radiation of the surroundings which have their maximum in the infrared range. This energy source will be employed mainly during the night. Even when a high temperature difference exists between th inner and the outer shell of th building, the heat gain btain d from the outside will by far exceed the heat loss of the inner building mass, grace to the installation of a suitabl insulation.

Further, the present invention has for its object a building comprising at least one room cell which can be heated by the method of the invention. According to the invention, this building is characterized in that the body from which the thermal energy is to be extracted, takes the form of a wall enclosing at least part of the building and that the said wall comprises a heat exchanger taking the form of a pipe system which can be connected to the heat pump.

A preferred embodiment of the invention provides that the building is provided with a double outer wall, that the external wall shell forms the mass from which the thermal energy is extracted, that the said outer wall shell is spaced from the inner wall shell and that the space between the two shells is filled over its full extension with a heat insulation and vapour barrier.

In this case, the inner wall shell provides the necessary stability and acts at the same time as heat accumulator for the room heating. The outer wall shell acts as absorbing and accumulating means for the energy supplied by the surroundings. As mentioned before, the two wall shells are mutually insulated against heat transmission and vapour diffusion.

Due to the laws of the flow of heat and its speed in different substances, the outer wall shell of this arrangement absorbs the environmental temperature, while the inner wall shell tends to assume the temperature up to the insulation, which prevents the heat transmission between the two shells.

Now, when heat is currently extracted from the outer shell by cooling means, the surface of the outer shell will continuously supply further energy without any further drop in the surface temperature of the shell.

The surface absorbing the energy radiation may even be enlarged by relatively simple means, for instance by the application of a special energy-absorbing plaster with rough texture. Moreover, the maximum of this plaster may be designed for the infrared range so as to increase the heat-absorbing capacity. Moreover, to improve the insulation of the building mass serving as heat accumulator against the outside with a view to preventing any transmission of heat, it has proved advantageous to insulate the inner wall shell not only from the outer wall shell, but also from the foundation and the roofing. The extremely high accumulation capacity of the building mass achieved thereby makes it possible to accumulate energy mainly during the peaks of the temperature amplitude. Considering that the temperature curve of the outer wall shell is somewhat displaced in phase in relation to the amplitude curve of a day's temperature, it does not pay to upgrade the energy during the morning hours. As a rule, the upgrading can be carried out most economically between 12 a.m. and 20 p.m., even though no cheap night current may be available during this time.

It may be sufficient already if at least the floor of at least one room cell to be heated and acting as accumulator can be heated by means of a heat exchanger which can be connected to the heat pump and which may in particular take the form of a pipe system. However, preferably all delimiting surfaces of a room, including the walls and the ceiling, will be designed as heating surfaces. In this case, it is also possible to connect the heat exchangers arranged in the individual delimiting walls of the cell in series, in particular during the cold time of the year so that an ideal temperature profile warranting the feeling of optimum comfort will be achieved in all rooms.

In a preferable embodiment, each room cell can be heated by a separate, in particular controllable heat exchanger system. Thus, it is possible to keep the individual room cells at different room temperatures according to the individual requirements, although the building masses enclosing the room cells serve as heat accumulator.

In another advantageous embodiment of such a building, the two heat exchanger systems of the outer and the inner shells can be directly interconnected, by-passing the heat pump. This offers the advantage that in the presence of direct sun radiation between the seasons, the temperature of the heat-accumulating mass of the outer wall shell will rise above that of the inner wall shell. The peaks of this temperature amplitude may be controlled via a differential temperature regulator and directly transmitted to the inner accumulator masses as long as the heat agent circulates between the two masses. The heat gain may be used for the cooler hours of the evening and the night, without the need to employ the heat pump. During the cooler hours of the evening, this provides an additional, and in particular free, means of heating the room cell.

The method of the invention offers also very special advantages during the summer time when the room cells should be cooled rather than heated. For, when the outer wall shell is directly interconnected with the inner wall shell, by-passing the heat pump, the lowest temperature value of the day/night temperature amplitude reached in the cooler hours of the night and morning can be retained in the building. When the circulation is entertained during the night time and interrupted during the day time, sufficient cooling achieved without any cost at all.

When according to another advantageous embodiment of the building heat is extracted from the foundations by means of heat exchangers which are arranged in the foundations of the building and which can be connected to the heat pump for extracting heat from the ground, the heat removal from the building can be achieved in an even more advantageous manner in that cooling energy is introduced into the building masses from the ground via the surface of the foundati ns.

Th installation of regulating means, for instance a four-way-valve, p rmits even active cooling through th heat pump, which is effected by the vapouriz r of the heat pump xtracting thermal energy from the inner building masses so that use is mad only of the pleasant radiant energy, dep nding on

the existing temperature. As compared to conventional air conditioning systems, this presents the advantage that no troublesome cooling blowers are needed.

A further improvement of the invention provides for control means for controlling the flow quantity of the agent within the heat exchangers of the outer wall shell in response to the temperature absorption by different outer wall portions. Such control means make it possible to adapt the circulation of the agent in the heat exchangers to the direction of radiation of the sun so that the highest flow quantities of the agent are obtained at the points where the highest quantities of thermal heat are encountered. This ensures the best possible exploitation of the thermal energy absorbed by the outer wall shell from its environment.

For heating hot water, temperatures of approx. 40° to 45°C are required. However, although the medium temperature of approx. 26°C generated by the heat pump is sufficient for heating the building, it cannot be used for heating up the required service water. This work could be performed on principle by a second heat pump adapted to extract heat from the heating cycle of the first heat pump and to supply at its outlet and at a temperature level of 40 to 45°C. However, here again the invention makes such an expensive and uneconomical installation superfluous, provided a heat pump is used in which the liquefyer is preceded by a preliminary heat exchanger for extracting the superheat of the vapourizing agent for heating up a service water reservoir.

This arrangement is based on the consideration that the work fed into the system by the compressor of the heat pump has initially the result to superheat the evaporized working agent of the heat pump and that heat of condensation of the superheated agent is radiated only after it has been cooled down to a lower and constant temperature.

According to the advantageous embodiment of the building explained herein, the superheat is most advantageously used to reach the higher temperature level necessary for heating up the hot water so that no additional second heat pump is required. Thus it is possible to reach an even higher efficiency of the whole system.

To ensure the serviceability of the method described above also at temperatures which are essentially below 0°C, an anti-freezing agent must be added when water is used as heating agent.

Further details of the invention will be apparent from the following description of an embodiment of the invention shown in the attached drawing, in which:

Figure 1 is a longitudinal section through a diagrammatic representation of a building which is heated in accordance with the invention;

Figure 2 is a functional diagram explaining the operation of the heat pump.

Figure 3 is a diagram showing the interconnections of heat exchangers used to extract heat from outer wall-shells and from the foundations of the building.

In the drawing, the building comprises an inner body 18 which is preferably made from concrete and which contains several room cells 10, 12, 14, 16. The said body is preferably fully enclosed by an outer cell 20. A space 22 between the said body and the said outer shell is completely filled with an insulating mass 24, which may for instance consist of rigid expanded polyurethane.

The building is covered by a roof structure 26 from which it is likewise separated by an insulation 28. In addition, the building 18 is insulated by an insulation 32 from the foundations 30 and the cellar. Thus, the inner building mass 18 is fully shielded against the outer shell and/or the foundations.

In the outer shell 20, there is arranged a heat exchanger system 34 with supply and return lines 36 and 38, respectively. To illustrate the circulation of the heating agents, these lines have been arranged in the drawing outside the building. Likewise, an heat exchanger system 34 is arranged between the roofing and the insulation 28.

Moreover, each room cell has arranged within the building mass 18 an inner heat exchanger system 40 communicating with at least one heat pump 46, via a supply line 42 and a return line 44. On the other hand, the supply and return lines 36, 38 also communicate with the said heat pump. Another heat exchanger system 48 is arranged within the foundation of the building and can be connected via a regulator 50 with the line 38 which supplies thermal energy.

The room temperature desired in the individual room cells can be pre-selected and maintained constant by thermostats 52 which may either be arranged within the respective room cell itself or combined in a central regulating arrangement. The sensors of such thermostats are arranged in the return line 44 to adjust the flow quantity in the respective exchanger system of the room cell. i.e. in the supply line 42, in accordance with the pre-selected temperature.

In Figure 1, the room cell 16 accommodates the heat pump 46. However, for clarity's sake, the heat pump has been represented in the drawing outside the building.

The heat pump is connected to a hot water reservoir 54 for heating up the necessary service water. The hot water reservoir 54 comprises a vapourizer 56, a compressor 58 and a liquefyer 60. Between the compressor 58 and the liquefyer 60, a preliminary h at exchanger 62 is provided which extracts superheat from the vapourizing agent f the heat pump and supplies it to the hot water reservoir 54.

The outer surface of the outer shell 20 is provided with a layer, preferably 4 to 6 mm thick, of a special energy-absorbing cast 64 of rough texture.

The operation of the method of the invention f r heating up th room cells is as follows:

Under winter conditions, the energy gains are first upgraded by a water-to-water heat pump and then transmitted to an inner building mass or building shell 18. To this effect, the energy must be transported from the existing outside temperature to the medium temperature of the agent of say 26°C, if a room temperature of say 22°C is to be achieved.

Considering, however, that different temperatures are desired in the different room cells, the building masses used as accumulator for the thermal energy are adjusted by means of thermostatic valves 52 to the desired comfortable temperature, with the return temperature of the heat exchangers 40 of the building masses acting as temperature-indicator.

The frost-protected cycle of the heating agent extracts heat from the outer shell, the surface of which is again re-heated by environmental radiation, and transports it via line 38 to the vapourizer 56 of the heat pump 46. Following the heat extraction, the agent returns to the heat exchanger system 34 of the outer shell 20 at a lower temperature level; it is again ready to absorb heat, and thus the cycle is closed.

The energy gain is taken over by vapourization of the vapourizing agent of the heat pump, then raised in temperature by compression work performed by the compressor 58 and finally transmitted by liquefaction to the hot circuit of the inner heat exchanger system 40. However, the vapour of the vapourizing agent which carries the total heat resulting from the compression work and the superheat, must initially pass the preliminary heat exchanger 62 which heats the heating agent of the service water system.

The supply line 42 and the return line 44 connect the accumulator masses of the building, which are for instance heated up to 22° to 26°C, to the liquefyer 60 of the heat pump. The heat emission into the room cells is effected by radiation and, to a small extent, also by convection. During winter time, the distribution should be preferably realized by connecting the individual elements of the room cell in series in the following order: floor, walls, and finally the ceilings. Thus, an ideal temperature profile will be reached in all rooms.

Heating between the seasons:

Direct sun radiation will raise the temperature in the accumulator mass 18 above the temperature of the inner water circuit. The peaks of such temperature amplitude may be directly transmitted to the inner heat exchanger system 40 via a by-pass 66 and a differential temperature regulator 68, so long as the heating agent circulates between the two masses, which circulation may be achieved by the use of corresponding circulating pumps 70. The heat gain may be used for the cool hours of the evening and the night, by-passing the heat pump.

Heating of the room cells during summer time:

When communication between the outer heat exchanger system 34 and the inner heat exchanger system 40 is realized via the by-pass 66, the lowest value of the day/night temperature amplitude which is reached in the cool hours of the night and the morning may be stored in the building. Thus, a pleasant cooling effect at minimum operating costs is achieved by maintaining the circulation during night time and interrupting it during day time. Additional cooling of the foundation and heat removal from the building may be achieved through the heat exchanger system 48 in the foundation.

The energy savings achievable by the use of the method of the invention are demonstrated by the following comparing efficiency calculation:

When

W denotes the thermal efficiency in kcal/DM;

W_1 denotes the thermal equivalent of electric current (860 kcal/kW);

P_E denotes the price per kW of electric power; and

ε the performance coefficient of the heat pump and

φ denotes its efficiency,

and when the typical values of 4.5 and 0.88 achieved for a building of the invention are used for ε and φ, the following formula is obtained:

$$W = \frac{W_1 \cdot \varepsilon \cdot \varphi}{P_E} = \frac{860 \times 4.5 \times 0.88}{0.1} = 34\,056 \text{ kcal/DM}$$

Assuming comparable constructional conditions, the calculation for an oil heating will be as follows:

$$W = \frac{\text{specific thermal efficiency in kcal/l} \times \text{technical efficiency coefficient} \times \text{operational efficiency coefficient}}{\text{unit price in DM/l}} = 17\,827 \text{ kcal/DM}$$

wherein th technical efficiency coefficient is 0.9, the operational efficiency of an oil heating is 0.7 and the unit price, which may of c urse vary, is 0.31 DM/l.

The above comparison shows that the method of the invention yields twice the energy quantity of a conventional oil heating at the same cost.

The building underlying the above calculations was designed as follows:

The building had an enclosed space of 860 m^3, of which approx. 300 m^3 were taken by the unheated cellar. The ground floor above the cellar comprising likewise approx. 300 m^3 was maintained at a constant interior temperature of 22°C. The garret having a volume of approx. 260 m^3 was only slightly heated, i.e. it was maintained during winter time at a temperature of 16°C.

The double-shell construction was employed for the walls of the ground floor and the gable walls of the garret. In addition, heat exchanger pipes for energy generation were intalled at a surface of approx. 90 m^2 on the southern side of the roof. For the roof itself, a double shell is not required, but the inside of the roof must be insulated. Where the double-shell construction was used for the walls of the building, the outer concrete wall forming the outer shell 20 was 12 cm thick, while the concrete walls forming the inner shell 18 were 14 cm thick. The space between the outer shell 20 and the inner shell 18 was filled by an insulating layer 24 having a thickness of 10 cm. The latter consisted of commercial rigid expanded polystyrene (stryropor PS 20). However, rigid expanded polyurethane may also be used for this purpose.

As regards the the heat exchanger pipes 34 and 40 embedded into the concrete of the outer shell 20 and the inner shell 18, flexible polyethylene pipes were used. These were arranged in a common plane along a spiral pattern comprising a supply spiral terminating in a return spiral. This ensures a uniform temperature level over the full extension of the exchanger surface. Normally, approx. 6 to 7 m of the said polyethylene pipe are installed per m^2 of the wall surface, while in the walls of bathrooms, twice this length is installed. The planes in which the exchanger pipes 34 and 40 of the outer shell 20 and the inner shell 18, respectively, are provided are arranged on both sides of the insulating layer 24 and directly adjacent thereto. The distance between the heat exchanger pipes and the insulating layer is approx. equal to the diameter of the heat exchanger pipes 34 and 40. The latter have an outer diamerer of 20 mm and an inner diameter of 16 mm. They are fastened to the side of a wire mesh facing the insulating layer 24, the said wire mesh serving at the same time to reinforce the outer shell 20 and the walls of the inner shell 18, respectively.

Thus, the heat exchanger pipes 34 of the outer shell 20 are arranged at the maximum possible distance from the surface of the outer shell 20 exposed to the environment of the building and absorbing the warms supplied by the latter. Likewise, the heat exchanger pipes 40 of the inner shell 18 are arranged at the maximum possible distance from that wall surface of the inner walls which radiates the heat into the rooms. This arrangement ensures the best possible temperature profile for the absorption and radiation of the heat across the wall.

The control of the heat pump and the heat exchangers 34 and 40 coupled therewith is ensured by means of a temperature indicator in the return of the heat exchanger 40 of the inner wall shell 18. When the return temperature drops below a pre-set value of say 21°C, the heat pump 46 is activated. During operation of the heat pump 46, the supply temperature in the heat exchanger 40 of the inner wall shell 18 is approx. 28°C. Considering that a large amount of the quantity of heat thus fed into the system will initially be absorbed by the heat accumulator formed by the inner wall shell 18, the return temperature will initially change only very little. Because of the accumulation effect of the inner wall shell 18 and the temperature profile which drops from the plane of the heat exchanger pipes 40 facing the insulating layer 24 towards its surface facing the interior of the room, the change encountered in the temperature at the inner surface will be very slight only and correspond essentially to the changes encountered in the return temperature recorded by the temperature indicator so that the latter may be taken as a direct indication of the room temperature existing within the building. This return temperature indicator which starts the heat pump 46 when the return temperature drops below the preset minimum value and which stops the pump 46 when the pre-set value is exceeded—an indication that the heat accumulator formed by the inner wall shell 18 is "completely filled"—provides in a very simple manner a most efficient temperature control within the building, and not even considerable variations in the outside temperature will impair the stability of such control.

Another point of importance must be seen in the accumulation effect of the 12 cm thick outer shell 20 of the building which is in a position to act as a buffer in the case of a rapid drop of the outside temperature, thus preventing notable changes in the efficiency of the heat pump, because due to the accumulation effect of the outer shell 20 the temperature existing in the area of the heat exchanger pipes 34 will drop much more slowly than that of the outer surface of the outer shell 20 which is in direct thermal contact with the environment. The temperature in the area of the exchanger pipes 34 will adapt itself to the outwise t mperature only when such low temperature periods should last for more than approx. 1 day. Accordingly, the temperature variations between day and night have no notabl influence on the efficiency of the heat pump. The temperatur level in the area of the exchanger pipes 34 will adapt itself to th utside temperature only when such low-temperature conditions last for extended periods, and in this case one must put up with a somewhat r duced efficiency of the pump 46. Howev r, experience shows that such low-temperature periods never last very long, at least not in the zones of moderate climate, and accordingly such temperature drops will not notably influence the econ my of the heating of the invention. Another favourable property of the

building of the invention resulting from the accumulation effect of the outer shell 20 lies in the fact that an extraction of heat from such accumulator will cool the latter down only in the area facing the insulating layer 24, while the temperature at the outer surface of the accumulator will practically remain equal to the environmental temperature. This eliminates the possibility of ice formation on the outer surfaces of the building.

Figure 3 shows a most advantageous connection of the heat-exchanger 34, arranged in the outer wall shells 20, and of the heat-exchanger 48, located in the foundations 30, with the heat-pump 46. Only one exchanger-unit of both of these exchangers 34 and 48, respectively, is shown. A plurality of such exchanger-units may be provded in a parallel-connection.

Return-lines 38 and 71 of these exchanger-units 34 and 48, respectively, are coupled by means of a mixing-valve 72. A common transport-line 74 leads from the mixing valve 72 to the vapourizer 56 of the heat pump 46. The heat transport agent from which heat is extracted in the vapourizer 56, flows back to the heat-exchangers 34 and 48 via return-line 73.

By the aid of mixing-valve 72, a pre-determined mixing ratio of the quantities of heat transport agent, flowing from the heat exchangers 34 and 48 to the heat pump 46, is selectable. Approximately equal dimensions of the heat-exchangers 34 and 48 supposed, this mixing ratio is 1:1.

Because of the temperature drop ΔT across the vapourizer 56 of the heat pump 46, this circuitry operates as follows: if the temperature of the heat transport agent in the heat exchanger 34 is by more than ΔT higher than the temperature of the heat transport agent in the heat-exchanger 48, during the operation of the heat pump 46, excessive heat is fed into the heat exchanger 48. This heat is stored then in the foundations 30 for later use. As stated above, the operation of the heat-pump 46 is controlled by the temperature in the return-line 44 of the heat-exchanger-system 40, by which upgraded heat is transferred to the inner wall masses 18 and to the interior of the building.

If the temperature in the heat-exchanger 48 is higher than the temperature of the heat transport agent in the heat exchanger 34,—e.g. during the night- then, heat is extracted only from the foundations via heat-exchanger 48.

However, because of the temperature drop ΔT across the vapourizer 56 of the heat pump 46, no "excessive" heat is fed back into the heat exchanger 34 of the outer wall shells 20.

Claims

1. A method for heating and supplying thermal energy to a building using a heat pump for extracting heat from a heat reservoir via a primary heat exchanger, which heat can be transmitted at increased temperature through the use of external energy to at least one secondary heat exchanger which in turn transmits heat to an accumulator from which the quantity of heat necessary for heating up the room can be extracted, characterized in that the heat is extracted at the primary end from an outer wall mass (20) of the building (18,20), which is in thermal contact with the environment of the building, that an inner wall mass (18) which is thermally insulated against the outer wall mass (20) is employed as secondary accumulator and that the heat is transmitted to the interior of the building via the surfaces of the said inner wall mass facing the room cells (10, 12, 14, 16).

2. A method in accordance with claim 1, characterized in that the quantity of heat required for heating up the service water is extracted from the working agent of the heat pump (46) in its gaseous state which is superheated during the active phases of the heat pump (46) through the latter's compression work.

3. A building having at least one room cell which is heated in accordance with the method of claim 1 or 2, characterized in that an outer wall (20) enclosing the building at least partially comprises the primary heat exchanger (34) taking the form of a pipe system through which the quantity of heat that can be extracted from the outer wall (20) can be fed into the heat pump (46).

4. A building in accordance with claim 3, characterized in that the building is provided with a double outer wall, that the external wall shell (20) forms the mass from which the thermal energy is extracted, that the said outer shell is spaced from the inner shell (18) and that the space (22) between the two wall shells is filled over its full extension with a heat insulation and vapour barrier (24).

5. A building in accordance with claim 4, characterized in that the outer wall shell (20) is at least appox. 12 cm, the insulating layer (24) approx. 10 cm and the inner wall shell (18) at least approx. 14 cm thick.

6. A building in accordance with any of claims 4 or 5, characterized in that the inner wall shell (18) is insulated not only from the outer wall shell (20), but also from the foundation (30) and the roofing (26).

7. A building in accordance with any of claims 3 to 6, characterized in that at least part of the inner wall shell (18) of the building can b heated by means of a heat xchanger that can b connect d to the secondary end of the heat pump (46), and which preferably takes the form of a pipe system (40).

8. A building in accordance with any of claims 4 t 7, characteriz d in that the pip system of the heat exchanger (34) of th outer wall shell (20) is installed in a plan arranged essentially closer to th insulating layer (24) than to the outer surface of the outer wall shell (20) which is exposed t the surrounding temp rature.

9. A building in accordance with claim 7 or 8, in combination with claim 4, characterized in that the pipe system (40) forming the secondary heat exchanger, where installed in the double-wall structure (18, 20), is installed in a plane of the inner wall shell (18) arranged essentially closer to the insulating layer (24) than to the surface of the inner wall shell (18) facing the rooms (10, 12, 14, 16).

10. A building in accordance with claim 3 and any of the preceding claims 7 to 9, characterized in that the pipe systems of the heat exchangers (34) of the outer wall shell (20) and/or the inner wall shell (18) consist of flexible polyethylene pipes having a wall thickness of approx. 2 mm and an outer diameter of approx. 20 mm, and that the said pipes are embedded in concrete into the outer shell (20) and/or the inner shell (18) along a meander and/or spiral pattern comprising a forward spiral terminating in a return spiral.

11. A building in accordance with any of claims 3 to 10, characterized in that the floor of at least one room cell (10, 12, 14, 16) of the building to be heated can be heated by means of a heat exchanger taking the form of a pipe system (40) which can be connected at the secondary end to the heat pump (46).

12. A building in accordance with any of claims 3 to 11 comprising a plurality of room cells, characterized in that each room cell (10, 12, 14, 16) can be heated by means of a separate, in particular controllable, heat exchanger system (40).

13. A building in accordance with any of claims 7 to 12, characterized in that the two heat exchanger systems (34, 40) of the outer and inner wall shells (20, 18) can be directly interconnected, by-passing the heat pump (46).

14. A building in accordance with any of claims 3 to 13, characterized in that the foundations (30) of the building are provided with heat exchangers (48) which can be connected to the heat pump (46) for extracting heat from the ground.

15. A building in accordance with any of claims 7 to 14, characterized in that the temperature of the room cells (10, 12, 14, 16) can be controlled via thermostatic valves (52) in response to the return temperature in the heat exchanger (40) of the inner wall shell (18).

16. A building in accordance with any of claims 3 to 15, characterized in that control means are provided for controlling the flow quantity of the agent in the heat exchangers (34) of the outer wall shell (20) in response to the temperature absorption by the various parts of the outer wall shell.

17. A building in accordance with any of claims 3 to 16, comprising in particular a heat pump consisting at least of the following units: vapourizer, compressor and liquefyer, characterized in that the liquefyer is preceded by a preliminary heat exchanger (62) for extracting the superheat of the vapourizing agent for the purpose of heating a service water reservoir (54).

18. A building in accordance with any of claims 3 to 17, characterized in that the outer surface of the outer wall shell (20) is provided with an energy-absorbing cast (64), in particular one of rough texture.

19. A building in accordance with any of claims 3 to 18, characterized in that water with an admixture of an anti-freezing agent is used as thermal agent in the heat exchangers (34, 40).

20. A building in accordance with any of the preceding claims 14 to 19, characterized in that the pipe or pipes (38) of the primary heat-exchanger (48) of the foundation (30) of the building, through which pipes (38, 71) heat carrying fluid is transported to the vapourizer (56) of the heat pump (46), are interconnected by mixing-valve-means (72) by which a predetermined mixing-ratio of these fluid-currents, flowing to the heat-pump (46) is selectable.

21. A building in accordance with claim 20, characterized in that in the case of approx. equal dimensions of the heat-exchangers (34 and 48) in the outer wall-shells (20) and in the foundations (30), respectively, the said mixing-ratio is 1/1.

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